University of BRISTOL

Estimating Flood Peaks from Event Runoff Depth and Hydrograph Time Scales

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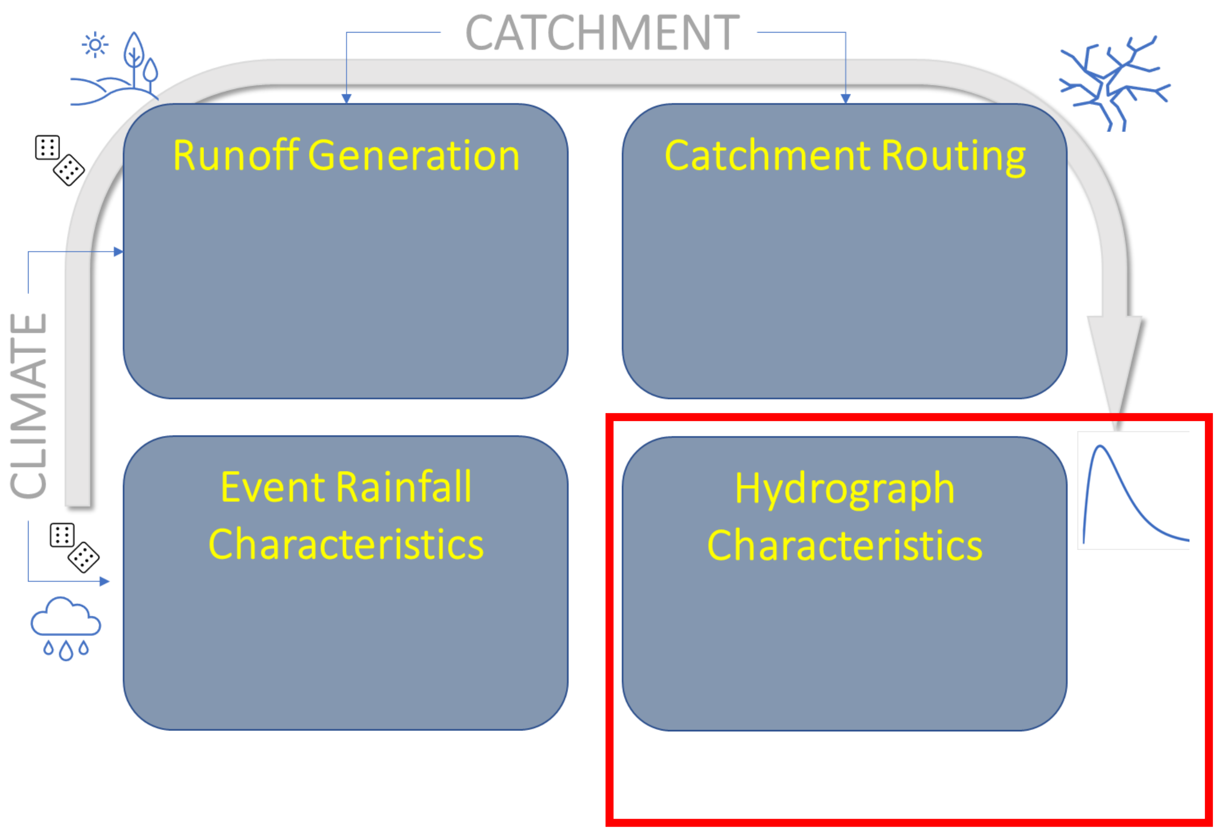
Goal & Method Overview

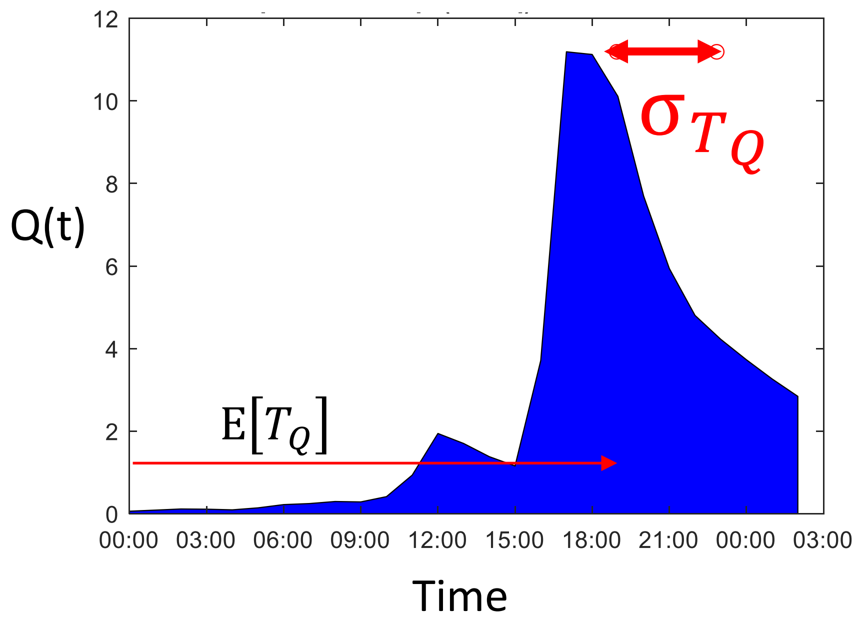
- Goal: understand and quantify river flood occurrence & size, using hydrological processes, climate and landscape characteristics
- Application: Estimate flood frequency curves in ungauged catchments by the derived distribution approach

For a brief introduction, see YT link in display materials



Research Question

- Suppose we have methods to estimate
  - Runoff depth, R
  - Hydrograph “width” σ_{T_Q}



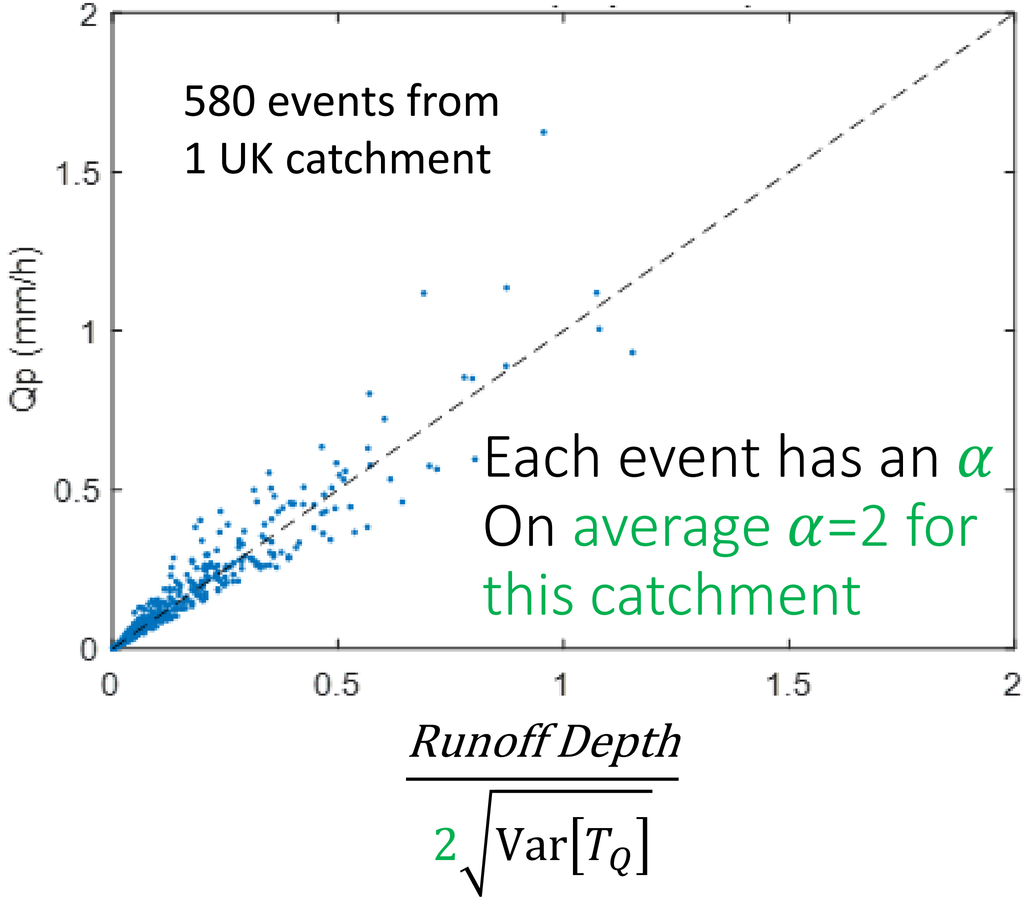
- Then how do we estimate the flood peak?

$$Q_P \approx \frac{R}{\alpha\ \sigma_{T_Q}}$$

  - Is the data consistent with this functional form?
  - What is the value of α?

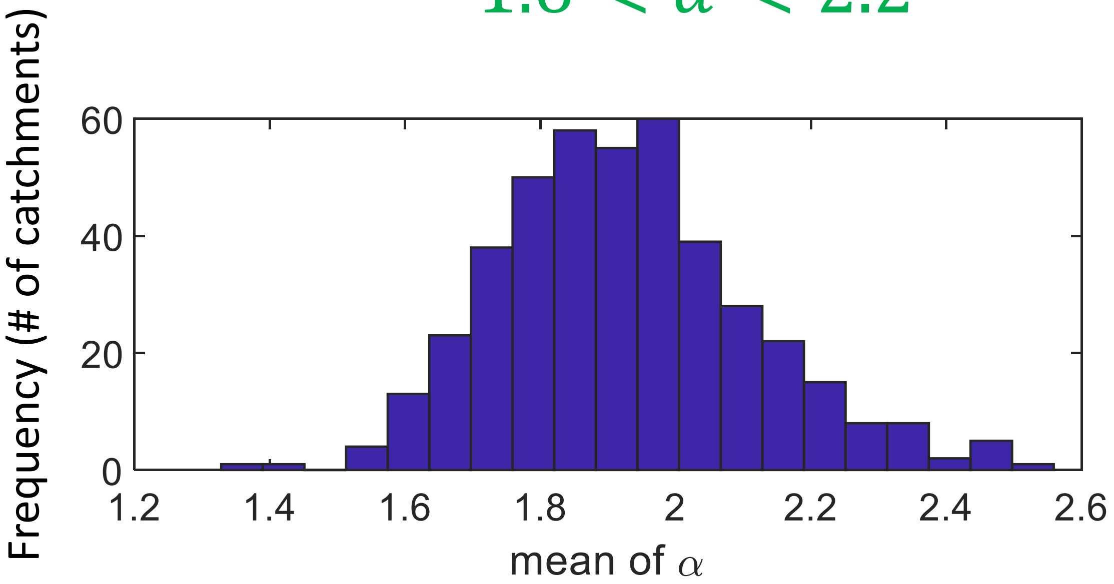
(For more on σ_{T_Q}, see Viglione et al 2010a,b and Gaal et al 2012)

In the UK, does $Q_P \approx \frac{R}{\alpha\, \sigma_{T_Q}}$?

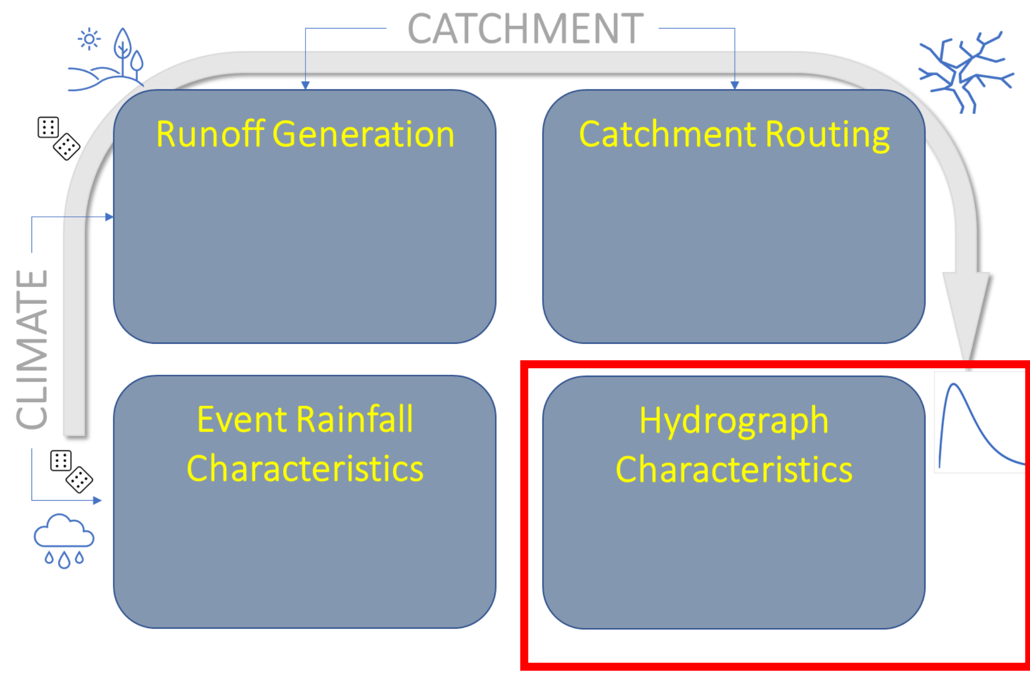


280,000 events from
430 UK catchments - Giani et al (2022)

For most UK catchments,
$1.6 < \bar{\alpha} < 2.2$



What Next?



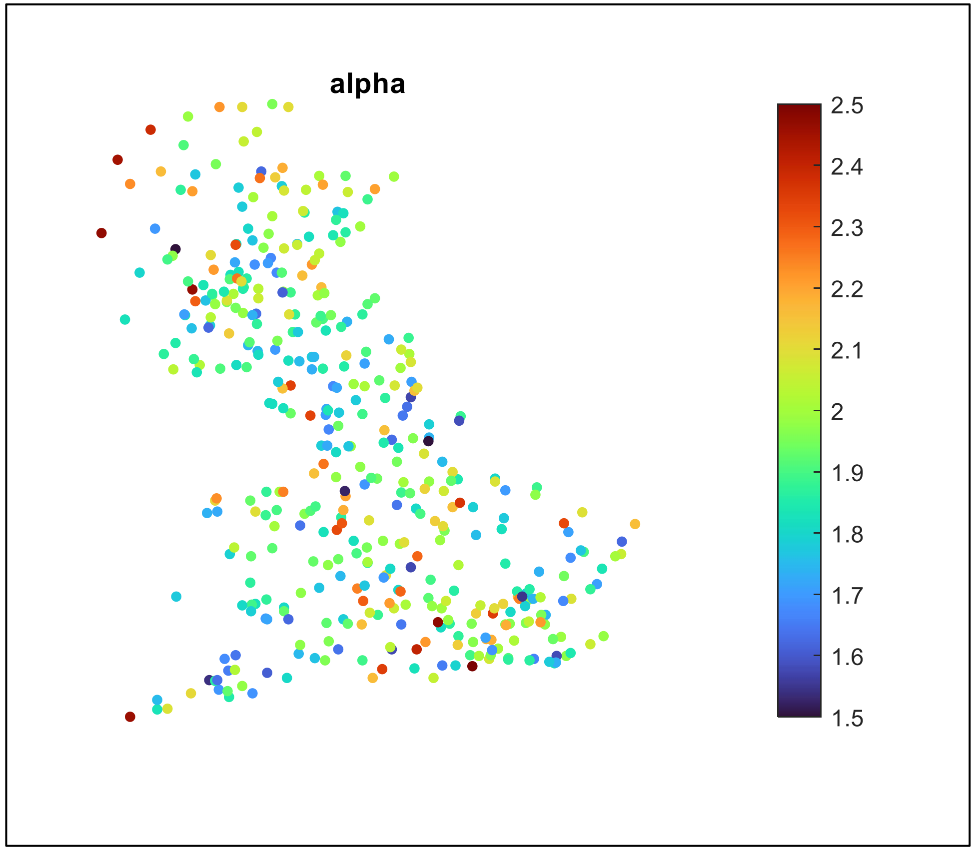
- Results: $Q_P \approx \dfrac{R}{\alpha \, \sigma_{T_Q}}$, with $1.6 < \bar{\alpha} < 2.2$

- Why does α have that value?
- For flood estimation, how to treat α?
  - Universal constant = 2?
  - Varying between events? (need a pdf)
  - Systematically varying between events (conditional pdf)
  - Spatially varying? (regionalise?)

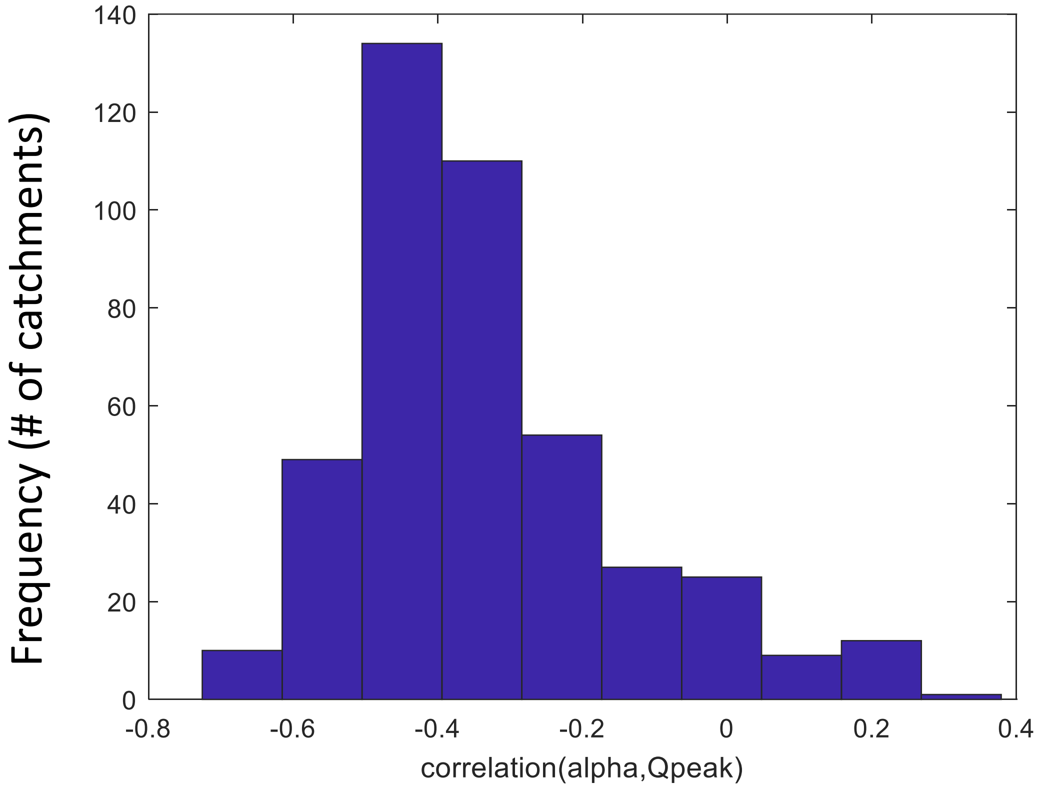
References

- Gaal et al (2012) https://doi.org/10.1029/2011WR011509
- Giani et al (2022) https://doi.org/10.1029/2021WR031283
- Viglione et al (2010a) https://doi.org/10.1016/j.jhydrol.2010.05.047
- Viglione et al (2010b) https://doi.org/10.1016/j.jhydrol.2010.05.041
- Woods and Sivapalan (1999) https://doi.org/10.1029/1999WR900014

Catchment average α weak spatial correlation

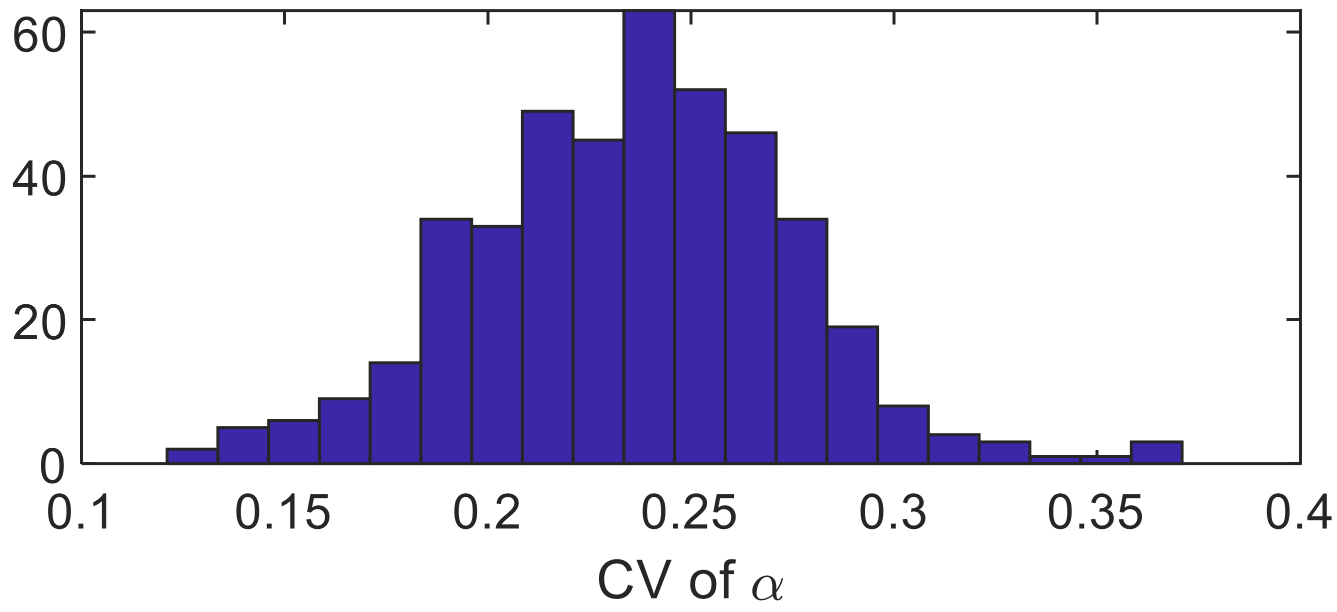


Larger events have smaller α



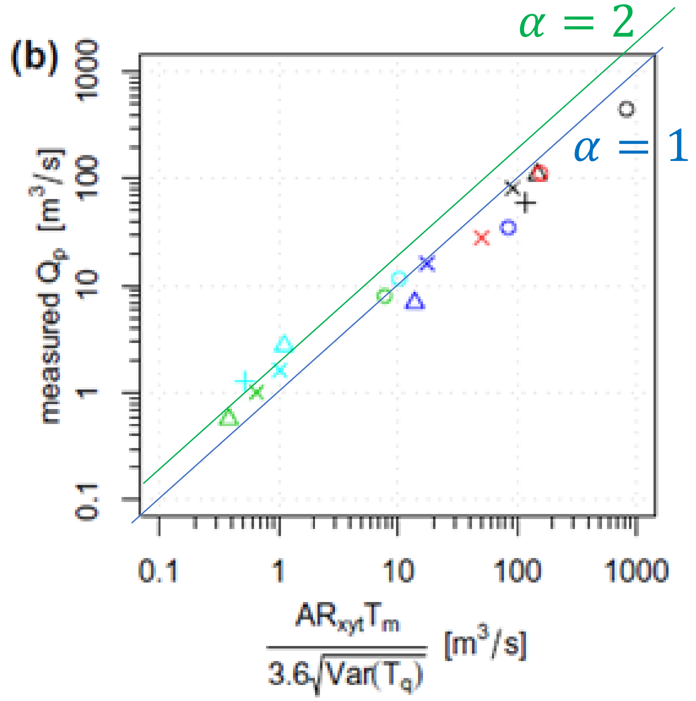
Spearman rank correlation

Between-event variation of α



Why is α closer to 2 than 1?

- Hmmm … because the data say so?
- It's *not inconsistent* with Viglione et al
- I did some **very simple** theoretical modelling
  - For exponential unit hydrographs with steady rain, $1 < \alpha < 3$
  - For triangular unit hydrographs, $2 < \alpha < 2.5$



Based on
Viglione et al 2010b, Fig. 11